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Providing High-Quality Video-on-Demand Service Using P2P Network

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Overview

- ❖ Background
- ❖ PONDER: Performance aware P2P VoD
- ❖ Evaluation
- ❖ Related work
- ❖ Summary

- ❖ Credits:
 - Princeton Lab: Saurabh Mathur, Kumar Ramaswamy, Patel Bankim
 - Rutgers WINLAB: Shengchao Yu

Background

❖ P2P technique attracting attentions from commercial world

- ❑ Akamai => Red Swoosh VeriSign => Kontiki
- ❑ Startups providing P2P live program: pplive, ppstream, etc.
- ❑ BBC test run of IMP
- ❑ Joost
- ❑ **Why?**
 - Reduce the cost to compete with piracy
 - Explore new business model

❖ VoD picking up steam

- ❑ Cable operators
 - Economics: Comcast embedding ads in VoD programming
- ❑ YouTube, many web sites
- ❑ Success of NetFlix

Background

❖ Issues with VoD service

- ❑ From user's perspective - QoS requirement: viewing quality must be good; prompt start
- ❑ From service provider's perspective - resource consumption must not be overwhelming

❖ P2P VoD - CoopNet, P2Cast, DirectStream, etc.

❖ Schemes proposed so far are best-effort in nature

- ❑ Few address QoS issue

❖ Our goal: design a scalable and high-quality VoD service

PONDER: Performance Aware VoD Service

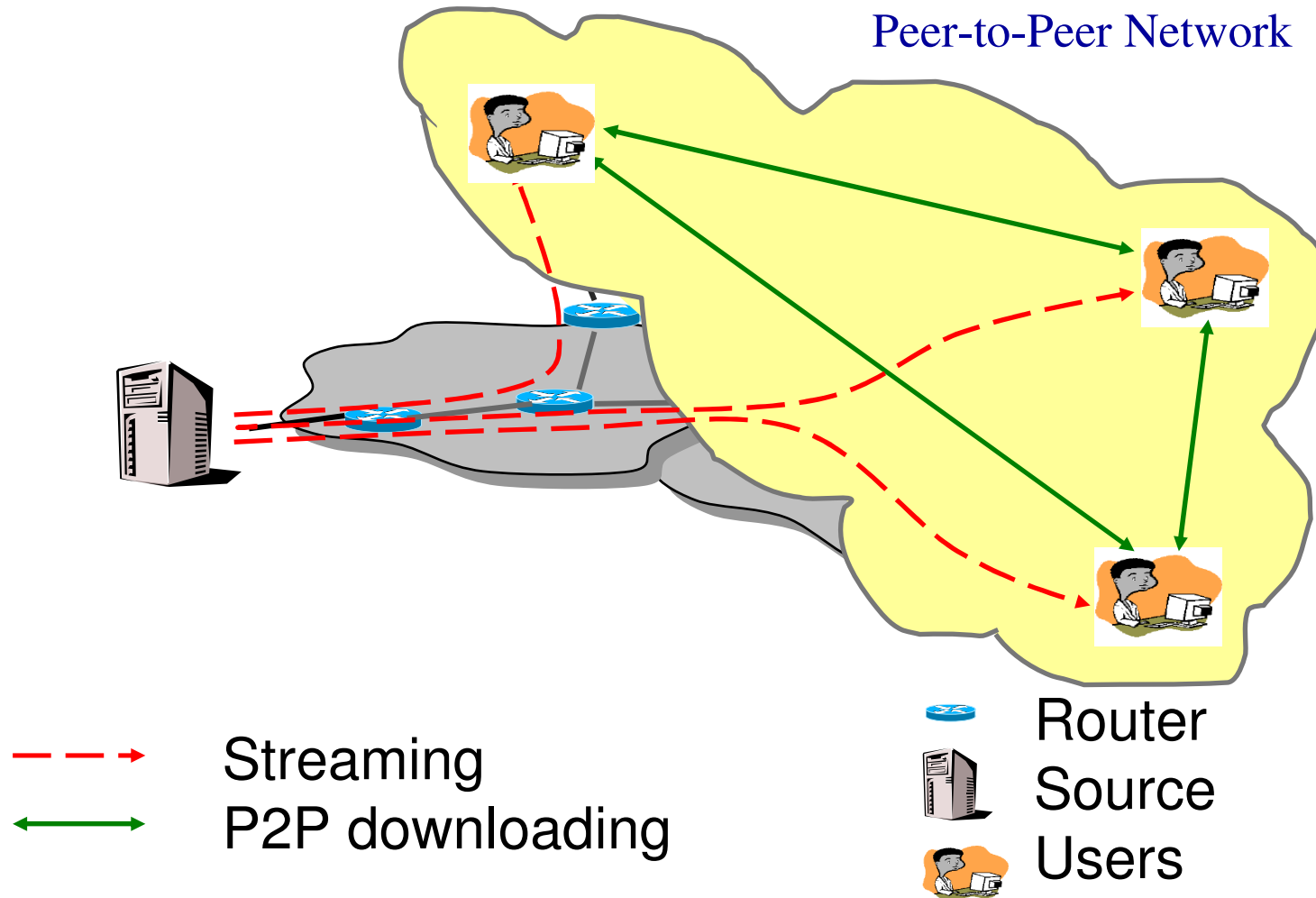
❖ **Dual approach:** incorporate the P2P downloading into server-based VoD service

- P2P downloading serves a significant portion of data thereby reducing the load on the server
- Server devotes most of its resources to improve quality
 - Immediate playback
 - Good viewing quality

❖ **Introducing real-time scheduling into peer-selection**

- Provide better viewing quality

PONDER Architecture



PONDER

❖ Key technical questions

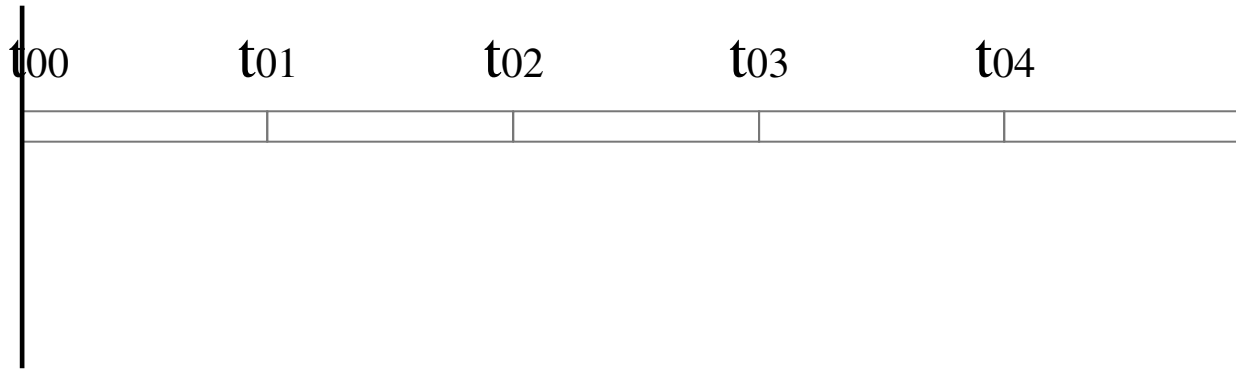
- ❑ How to share data?
 - Remember in VoD, users arrive at different time
- ❑ How to provide high quality?
 - Perceived quality should be comparable with that offered by traditional client-server service model

❖ PONDER - QoS aware P2P video-on-demand service

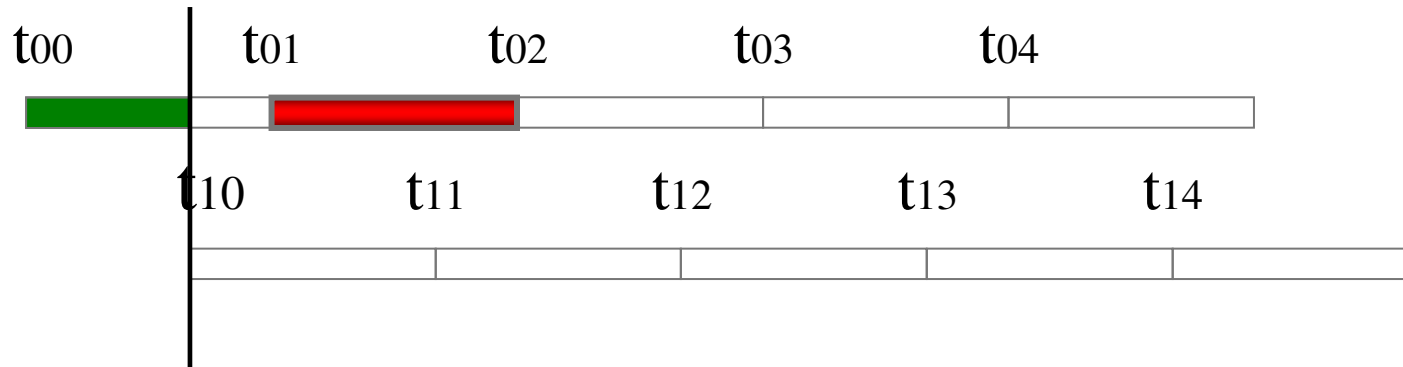
- ❑ Segmented P2P data sharing
- ❑ QoS sensitive P2P downloading
- ❑ Complimentary server streaming
- ❑ Measurement based admission control



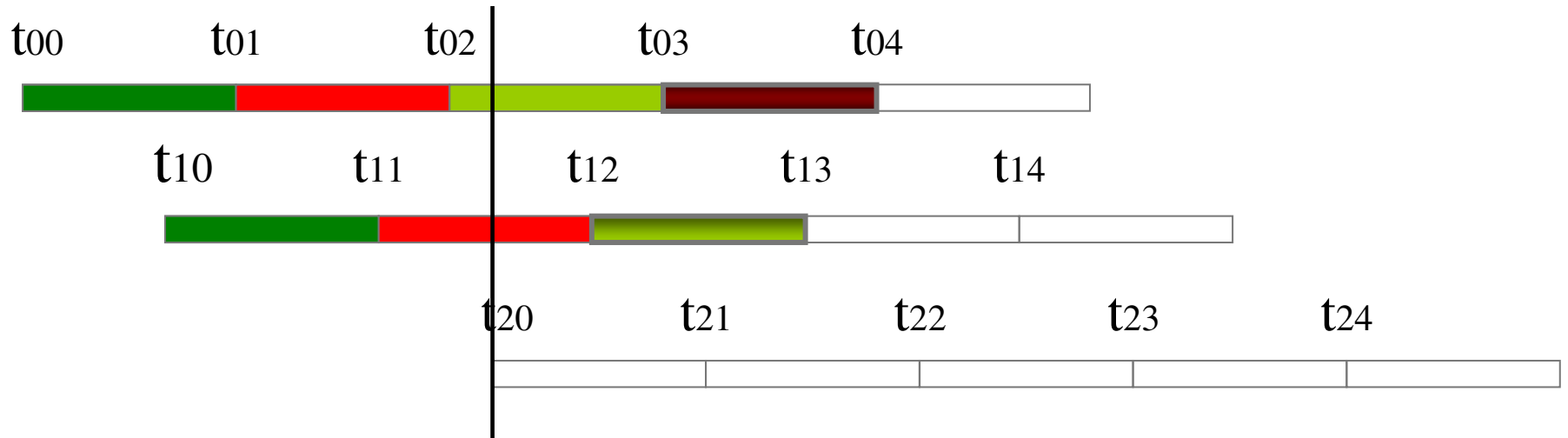
An Example



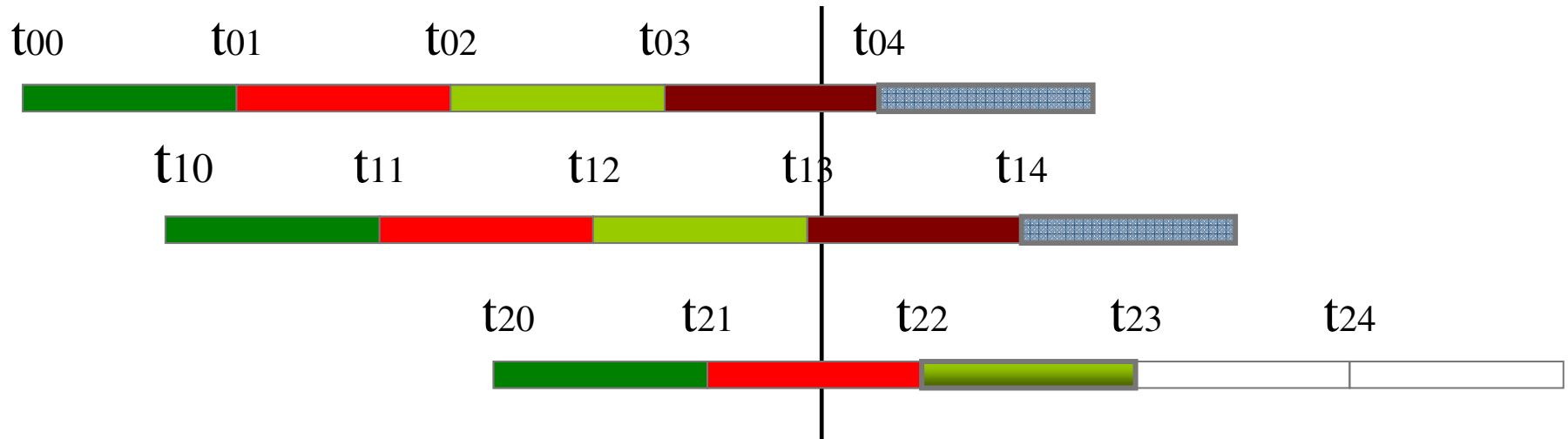
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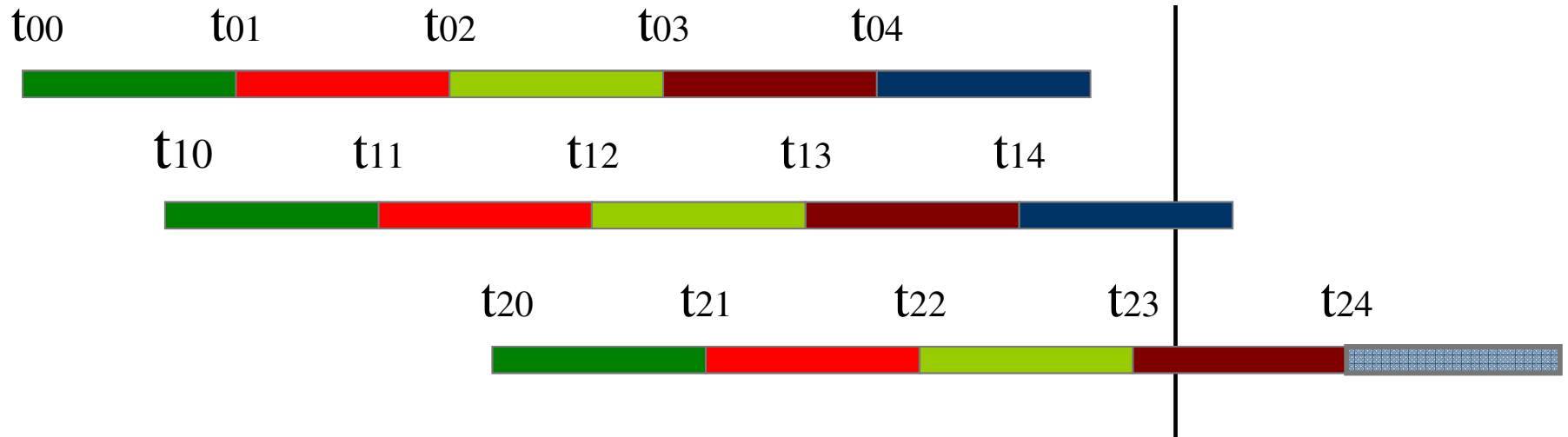
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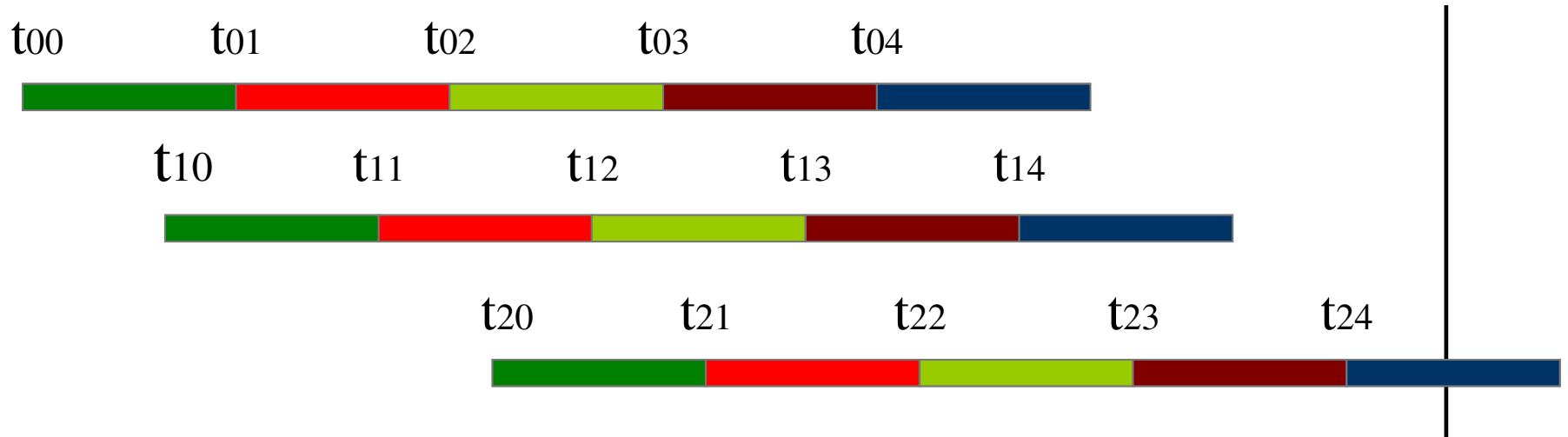
An Example



An Example

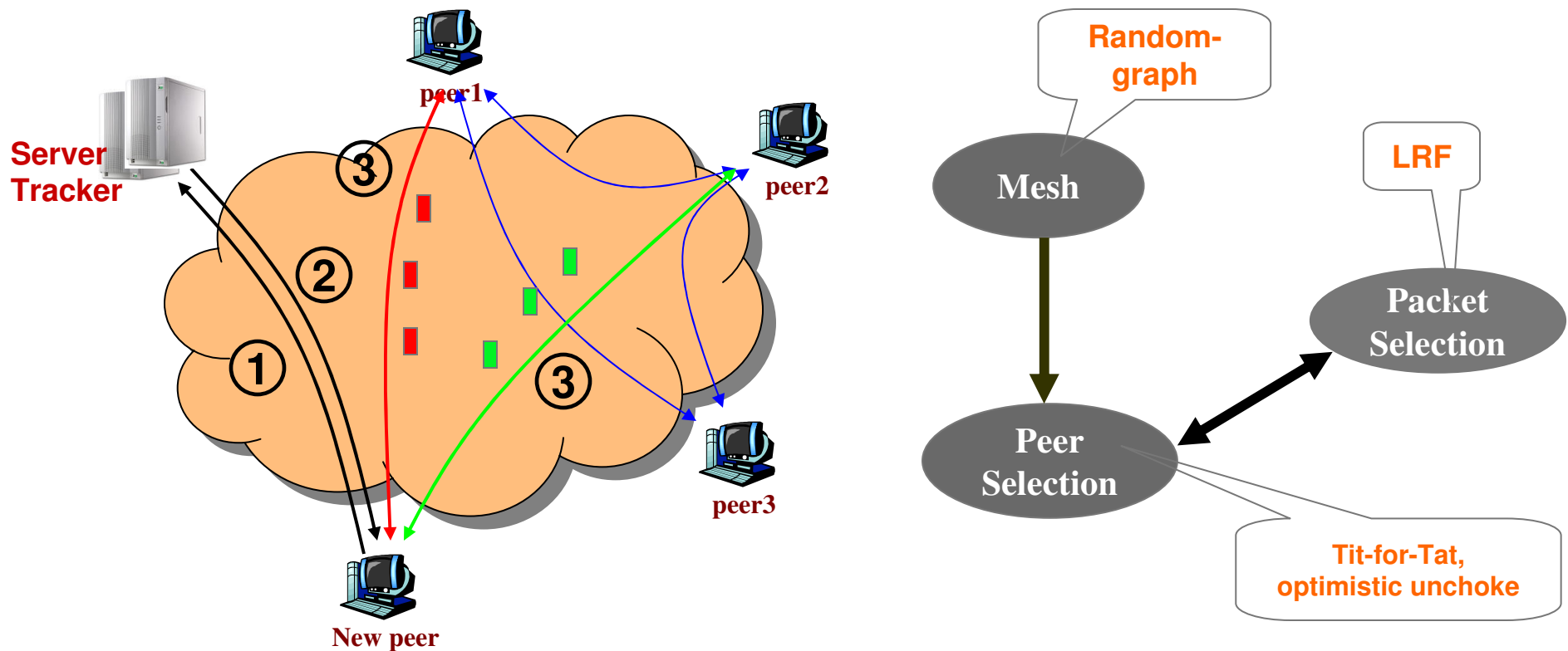


An Example



QoS Aware P2P Downloading

❖ BitTorrent-like data-driven p2p network



QoS Sensitive Peer Selection

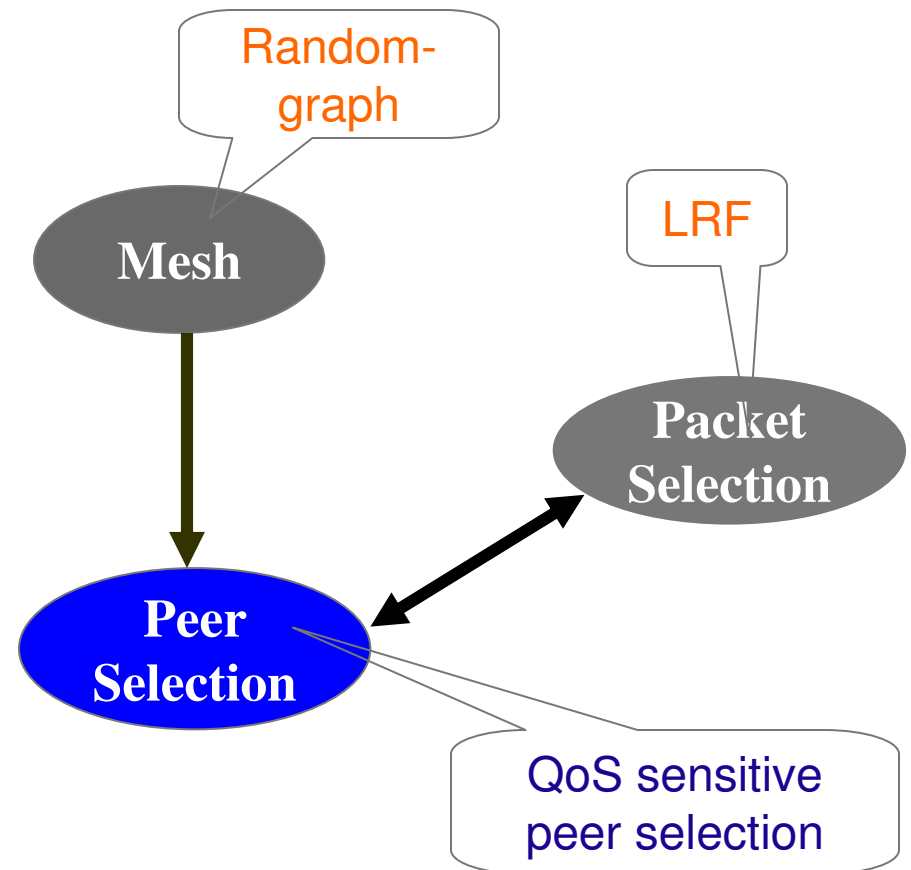
❖ Meeting all deadline is the goal

❖ Factors considered

- ❑ How urgent is the request?
- ❑ Is the downloading on schedule?
- ❑ How many potential peers are available?

$$N_i^{seed} = \lambda(L - i \bullet T)$$

- ❑ What is downloading speed?



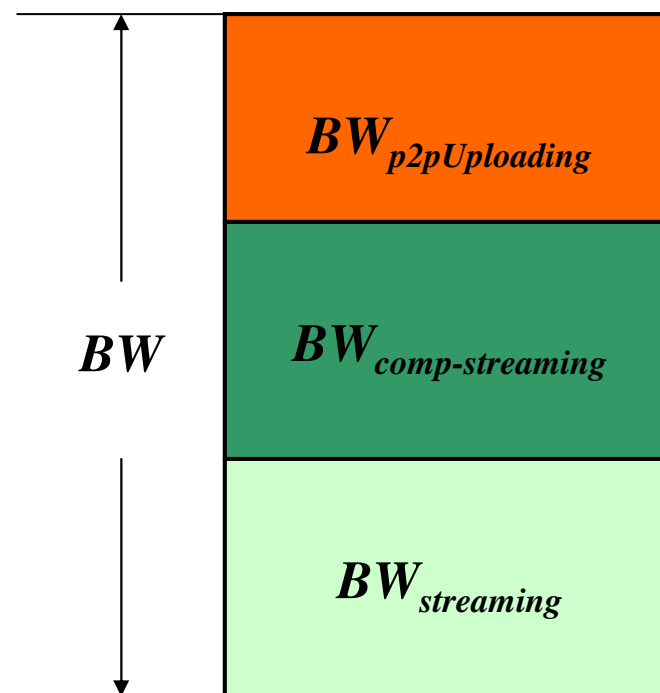
Server Bandwidth Usage

❖ Server has three responsibilities:

- ❑ Streaming leading sub-clip
- ❑ Complementary streaming
- ❑ P2p uploading

❖ Different impact on QoS

- ❑ Instantaneous play back
- ❑ Filling "holes" by playback time
- ❑ Un-sufficient seeding -> missing data by playback time



Measurement Based Admission Control

- ❖ Step 1: Determine if there is enough bandwidth for leading sub-clip streaming

- Guarantee immediate playback

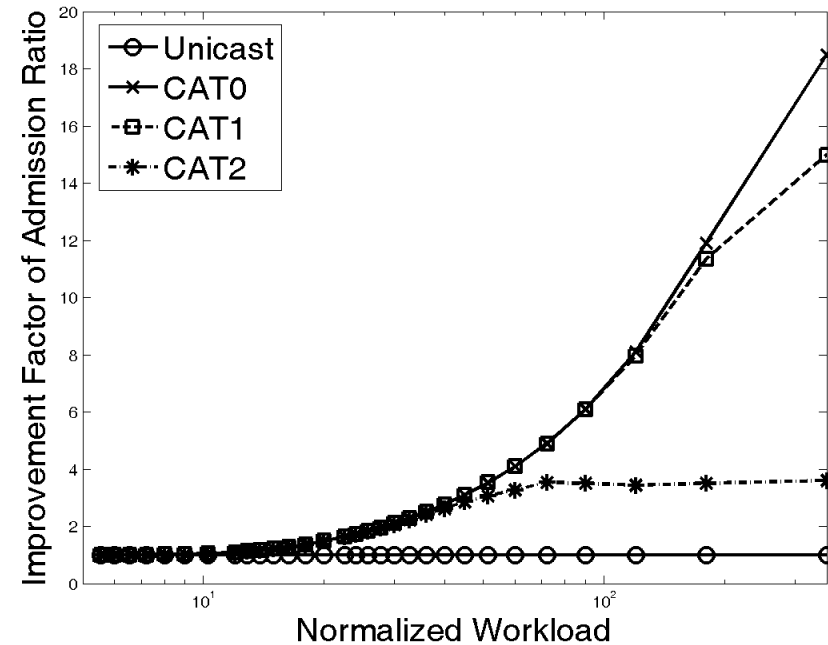
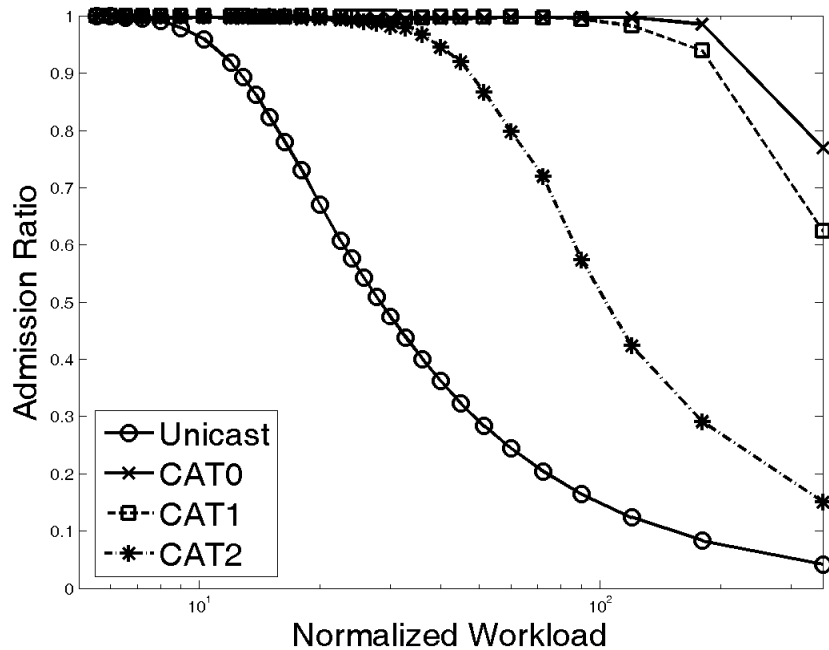
$$BW - (BW_{streaming} + BW_{comp-streaming}) > r$$

- ❖ Step 2: Determine if server has the bandwidth in the long run to admit new client without sacrificing viewing quality of users

- Required bandwidth for comp-streaming is a Bernoulli variable
 - Sum of Bernoulli variables

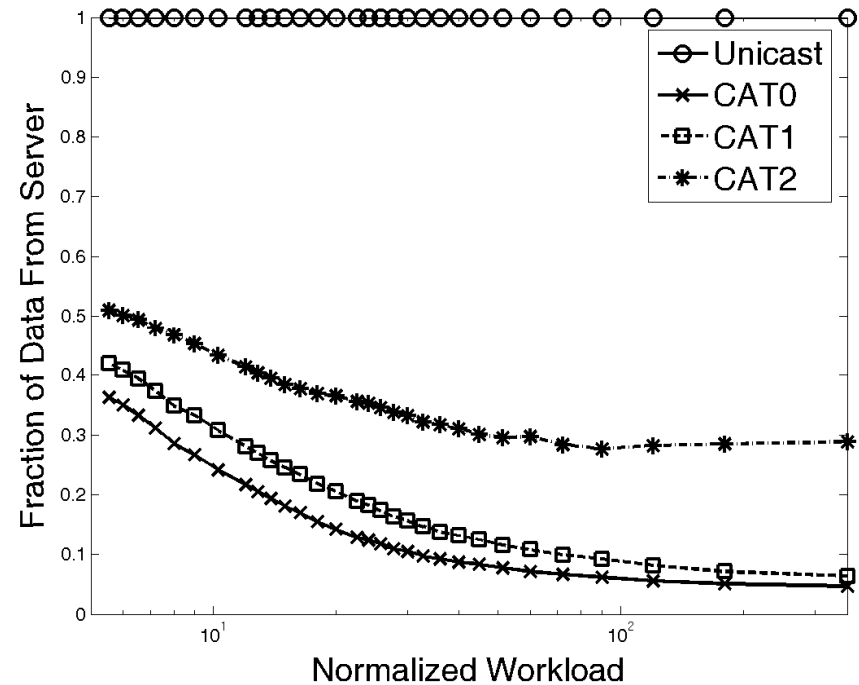
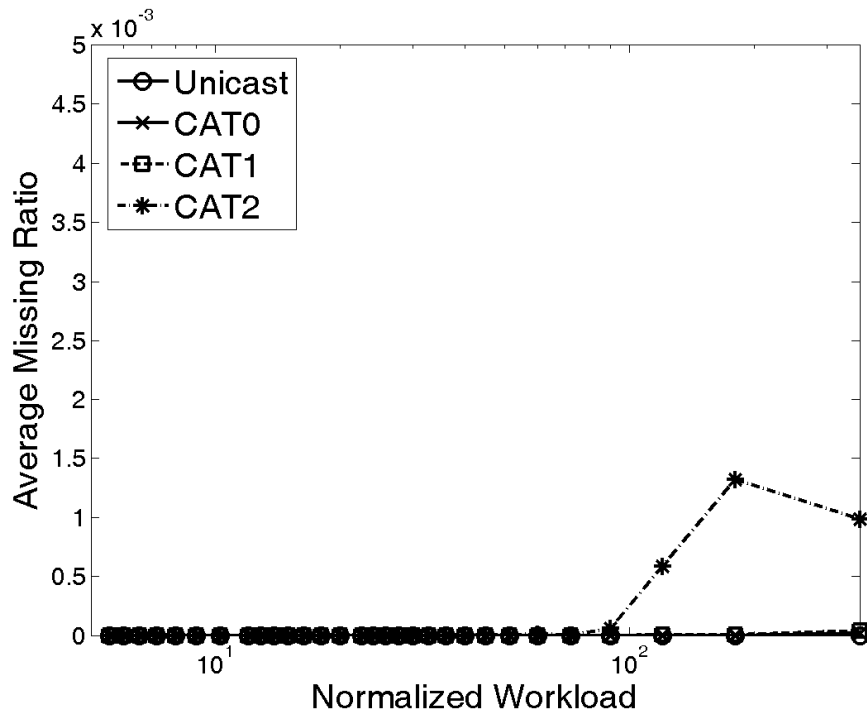
$$(N_s + 1) \bullet r + (N_{cs} \bar{b}_{cs} + \beta \sigma_{cs}) + (N + 1) \bullet \bar{b}_{p2puploading} < BW$$

Performance Evaluation: Scalability



Extended the admission ratio by a factor of ≥ 3

Performance Evaluation: Quality



QoS degrading is minor ($< 0.02\%$)
P2P network carries major workload

P2P VoD: Related Works

❖ Tree-based VoD

- Mesh or Tree? (Magharei, etc.) "Mesh is better"

❖ Mesh-based VoD

- *BiTos* (Vlavianos, etc)
 - Packet-selection gives higher priority to content close to play
 - Long startup delay, viewing quality not satisfactory
- *BASS* (Dana, etc)
 - Use native BitTorrent with server providing missing data
 - Not efficient, long startup delay, low quality

❖ Our contribution

- Hybrid approach with server's resource dedicated to offer good QoS
 - Strike good balance of scalability and quality
- Apply real-time scheduling mechanism to better suite p2p downloading for VoD

Summary

- ❖ Hybrid approach has benefits of both worlds
 - Client-server service model offers good quality
 - P2P alleviate workload on server, system is more scalable
- ❖ VCR operation can be supported naturally

- ❖ Future work
 - Design optimum mesh-based p2p VoD
 - What is the most appropriate way to construct mesh?
 - How to select peer?
 - Can we do better than LRF?
 - Secure p2p streaming
 - How to protect content?
 - How to make sure peers are trustworthy?

The End
/*!?!*/